A Commercial Thinning in Douglas-Fir with a Horse

by Alan B. Berg

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FOREST RESEARCH LABORATORY

The Forest Research Laboratory is part of the School of Forestry at Oregon State University. The industry-supported program of the Laboratory is aimed at improving and expanding values from timberlands of the State.

A team of forest scientists is investigating problems of growing and protecting the timberland crop, while wood scientists endeavor to make the most of the material produced.

The current report stems from studies of forest management.

PURPOSE . . .

Develop the full potential of Oregon's timber resource by

increasing productiveness of forest lands with improved practices;

improving timber quality through intensified management and selection of superior trees;

reducing losses from fire, insects, and diseases--thus saving timber for products and jobs.

Keep development of the forest resource in harmony with development of other Oregon resources.

PROGRAM . . .

REGENERATION through studies of producing, collecting, extracting, cleaning, storing, and germinating seed, and growing, establishing, and protecting seedlings for new forests.

YOUNG-GROWTH MANAGEMENT through studies of growth and development of trees, quality of growth, relationship of soils to growth, methods of thinning, and ways of harvesting to grow improved trees.

FOREST PROTECTION through studies of weather and forest fire behavior to prevent fires, of diseases and insects to save trees, and of animals to control damage to regrowth.

TREE IMPROVEMENT through studies of variation, selection, inheritance, and breeding.

CONTENTS

SUMMARY

A commercial thinning in a dense 40-year old Douglas-fir stand in western Oregon in 1960-61 resulted in returns above cost of operation. The logs removed were small with 75 percent 9 inches or less in diameter. Two men, using a small power saw to fell the trees and a horse to yard the logs, brought 2,400 board feet to the landing for each 8-hour day.

ACKNOWLEDGMENTS

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Mrs. Kenneth Bain kept records of time and cost.

The Oregon State Forestry Department, through its representative, George Schoppert, provided the research area, built roads, and administered the sale.

Citizens and the forest industry in the North Santiam community supported the project.

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By

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Forest Ecologist

INTRODUCTION

Large areas of forest in western Oregon are now or will be soon at the age when merchantable sawlogs, pulpwood, and poles and piling can be removed in intermediate cuttings. Such management will provide an early return and an increased total return by improving the quality of the stand and by salvaging trees that would die in the normal course of stand development.

Silviculturally, intensive management should begin in precommercial stands 15-30 years old, but the landowner may not be able to afford, or may not wish to begin, the management program until merchantable products can be removed at a profit--or at least for enough to pay costs of the logging operation.

The program of intermediate cuttings begun in 1960 on the North Santiam Forest Management Research Area is one of several in western Oregon undertaken by the Forest Research Laboratory, Oregon State University, to solve problems in managing young merchantable stands. Information from the first thinning is reported here, and a list of selected references has been added.

The research area is owned and administered by the Oregon State Board of Forestry. The Forest Research Laboratory has been authorized by that board and by the county court of Linn County to conduct research and experiments in the management of young-growth Douglas-fir on the area.

A series of 25 plots totaling 13 acres has been established on the area. Various levels of growing stock will be maintained to determine suitable management programs for merchantable young Douglas-fir. Trees on the plots have been classified and data recorded so that the effect of release on individual trees can be assessed. Costs and returns of management during the research period will be tabulated.

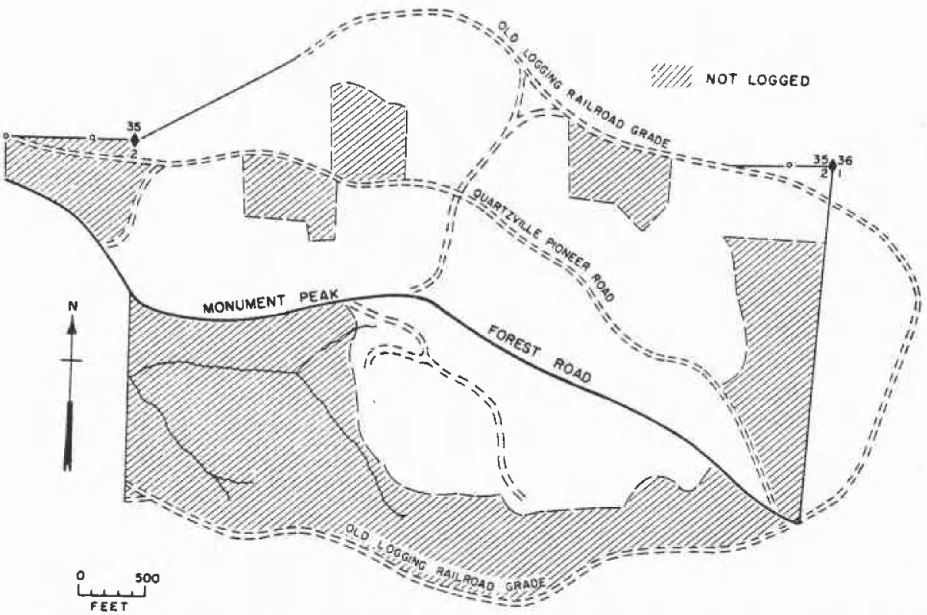

Figure 1. Map of North Santiam Forest Management Research Area showing roads. Shaded areas were not logged for comparison with other areas or because they were hardwood forests or had rough topography.

Description of the area

The 110-acre research area is south of Gates, Oregon, on the Monument Peak forest road 1 mile east of the Gates guard station.

Elevations range from 1,220 to 1,480 feet. Topography is gently rolling.

Soils are of the McCully and Tumble series derived from water-worked tuffs. Both soils are moderately well drained, stable on cuts and fills, and not easily erodible. The high content of gravel and stone of the Tumble series produces a hard-surface road that is operable even after winter rains. The McCully soils are not so rocky as the Tumble series, and care is needed in operating on dirt roads during wet periods. Dirt roads built on either of these soils, however, are passable for longer periods than roads on most other soils.

The Monument Peak forest road, which traverses the research area, is graveled and serves a large forested region for fire control, logging, and recreation (Figure 1).

Description of the stand

The dense stand is composed of young Douglas-fir which were 40 years old at time of logging. Data from 6,523 trees on the 13 acres of plots indicate that the total number of trees on an acre varied from 142 to 734. The average number of trees on an acre was 429, and on most of the plots the number clustered around the average (Figure 2).

The trees were small (see Table 1). Average DBH (diameter breast high) was 8.3 inches. The smallest average DBH on a plot was 6.1 inches and the largest, 12.1 inches. More than half the trees were 7 inches or less in diameter. Trees 8 inches and more in DBH ranged from 100 to 250 trees on an acre; the average was 197.

Site index on the area ranged from 150 (high site III) to 170 (middle site II). Volumes in board feet, Scribner rule, ranged from 19,000 to 31,000 board feet, with an average of 27,000 board feet an acre. Average number of 16-foot logs to a tree was 2.7.

Figure 2. The dense stand on the North Santiam Forest Management Research Area before the first thinning, 1960.

Table 1. Size Classification for Trees Marked for Cutting on the North Santiam Forest Management Research Area, 1960.

DBH	By number		By volume	
	Total marked	Percentage of all trees	Total marked	Percentage of all trees
Inches		Percent	Fbm[1]	Percent
7-10	1,032	53.3	64,170	25.0
11-15	718	37.1	113,950	44.4
15-28	186	9.6	79,030	30.6
Total	1,936	100.0	257,150	100.0

[1] Feet board measure.

EXPERIMENTAL PROCEDURE

This thinning, started in October 1960 and completed in August 1961, was a preliminary cut to remove trees of poor quality from the stand. In the 40 years before logging, the stand had developed many defective trees with broken tops, sweep, and large limbs. The removal of such trees favors well-formed vigorous trees. To remove all defective trees in this stand will require 2 or 3 cuts.

Marking

Wolf trees in the stand, those with wide-spreading crowns and large branches, had not seriously deformed adjacent trees. Many of the wolf trees could be removed to release well-formed trees with small limbs. Because this was done, several large logs were removed in thinning (Figure 3).

More small than large trees were logged. No tree under 8 inches DBH was cut, however, unless it contained a merchantable log and the tree's removal was important to improving future development of the stand. Most of the 7-inch trees removed were on the roadway.

Figure 3. A large tree (in center) marked for thinning because it had a crook and a double top. Trees like this one increased the average size of logs.

Table 2. Summary of Defect for Trees Marked for Cutting.

Volume	Fbm	Percent
Gross	257,150	100
Defect	41,180	16
Net	215,970	84

Volumes of trees were determined by a local volume table produced from sample trees measured on the area. Deduction for defect was high because many defective trees were marked for removal (Table 2).

The total number of trees marked was 1,936, with a range in DBH of 7-28 inches; the average DBH was 11.5. The total gross volume in board feet was 257,150; the average volume of the trees in board feet was 133 (Figures 4 and 5).

The logging operation

The logging was done by a two-man crew experienced in logging small timber.

Felling and bucking were done with a light power saw. In the dense stand, felled trees frequently caught on other trees and had to be rolled down with a peavy or, in difficult circumstances, pulled down by the horse. Only the merchantable length of the tree was limbed. Bucking, usually into 16-foot logs, was done in the woods before skidding.

The logs were skidded with a Percheron horse trained for logging. Skidding distances were short, with a maximum distance of 300-400 feet. The horse took logs to the landing one or several at a time depending upon their size.

Most logs were loaded from rollways, though an A-frame was used in locations where a rollway would not serve. With the A-frame, the horse provided power. Difference in time of loading between the two methods was not recorded.

More than 7,500 feet of secondary dirt roads were constructed to facilitate thinning. On the north side of the Monument Peak forest road, about 2,400 feet of railroad grade and 2,800 feet of the old pioneer Quartzville road were utilized in the road system (Figure 1). Both required substantial work, such as removal of trees and grading.

Hauling was contracted to an independent operator. Logs were taken to a mill 6 miles from the logging area.

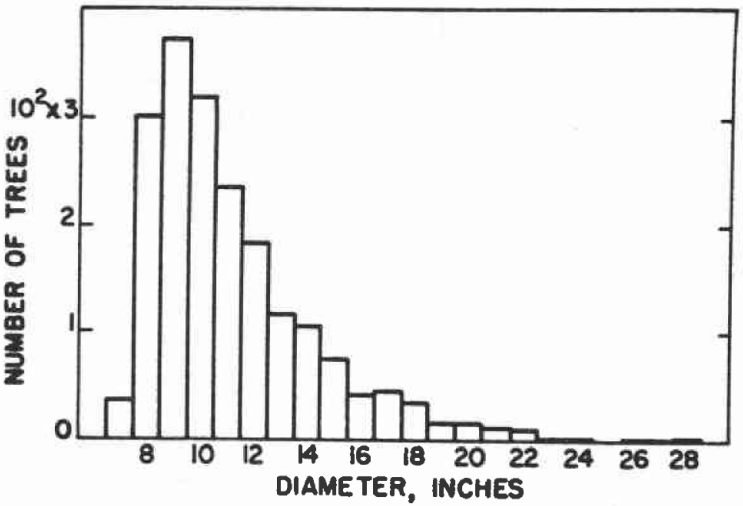

Figure 4. Distribution of trees by diameter, North Santiam first thinning, 1960-61.

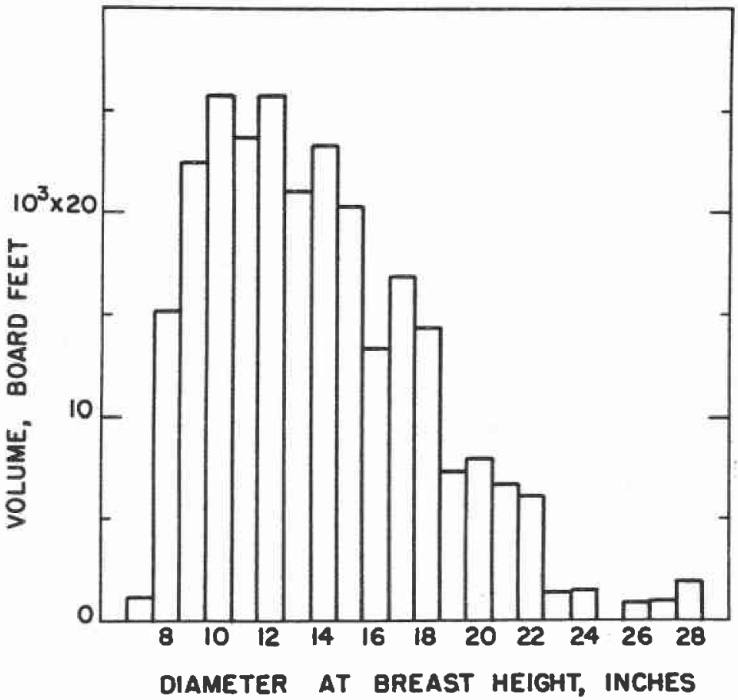

Figure 5. Volume by size of trees, North Santiam first thinning, 1960-61.

RESULTS

The results of the logging operation are expressed in log size and volume produced and in costs and returns to the operator. Because of the experimental nature of the operation, total costs cannot be shown. Costs of road building, direct management, and fixed ownership were absorbed by the Forest Research Laboratory and the State Forestry Department. These aspects are discussed and evaluated under an analysis of the operation in the Discussion section.

Size of sawlogs

Generally the logs were small. Over 75 percent of the number of logs and over 50 percent of the volume were in logs from 6 to 9 inches in diameter (Table 3; Appendix, Table 7; and Figures 6 and 7).

Other products, such as poles, pulpwood, posts and carstakes, could have been cut if markets had been available.

Production rates

Production rates have been calculated by man-hours for felling and bucking, skidding, all time to landing (felling and bucking plus skidding), loading, and all production loaded on the truck. Not included were road building or administration. Computation is based on total production of 215,970 board feet (Tables 4 and 5).

Construction of secondary roads

All tractor work in construction of roads was performed by the State Forestry Department with an International TD-24.

Table 3. Log Classification by Size.

Size class	By number		By volume	
	Total cut	Percentage of all logs	Total cut	Percentage of all logs
Inches		Percent	Fbm	Percent
9 and less	3,865	75.3	111,870	51.3
10-14	1,146	22.3	85,290	39.2
15-22	123	2.4	20,810	9.5
Total	5,138	100.0	217,970	100.0

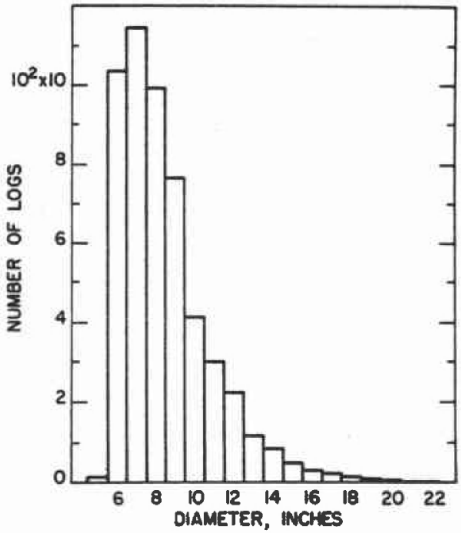

Figure 6. Distribution of log sizes in the first thinning on the North Santiam Forest Management Research Area, 1960-61.

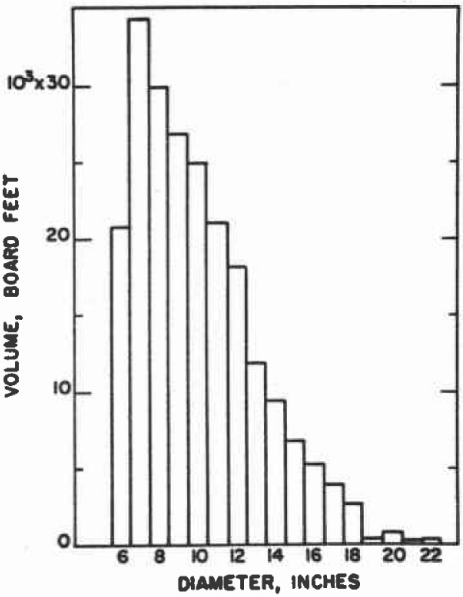

Figure 7. Volume by size of logs, North Santiam, first thinning.

Table 4. Time Expended on Extraction.

Item	Man-hours	Percent of total
Felling and bucking	677.0	37.2
Skidding with horse	756.5	41.6
Loading	281.0	15.5
Landing construction	70.0	3.8
Miscellaneous[1]	34.5	1.9
Total	1,819.0	100.0

[1]Miscellaneous includes such items as saw repair, horseshoeing, and delays for truck stoppage in mud.

The trees on the roadway were felled and the logs yarded separately from the road-building process; costs and returns were included in the logging operation.

The entire cost of road building should not be charged to this first operation, because successive thinnings will utilize the system. In this report, however, costs were not prorated to this and future thinnings.

The total length of road constructed was 7,685 feet, at a cost of $1,175.17. Thus the cost for each 100 feet of road was $15.29 and for each thousand board board feet of Douglas-fir removed, $5.44. Further breakdown of road-building costs appears in Appendix, Table 8.

Costs and returns to the operator

The operator earned a profit from the thinning. An average of 1,200 board feet was brought to the landing for each man-day worked.

The capital outlay by the operator was low. Costs of a small power saw, a horse and harness, and materials to construct an A-frame were the only expenses incurred.

The power saw cost $178.50 new. A horse and harness, which the operators already owned, could have been purchased for about $200. Supplies needed for the A-frame were estimated to cost $391.30. Capital outlay, then, need not have been more than $800 and might have been less.

Because many small trees were cut and consequently many small logs produced, the labor cost of extraction was high. Man-hours ex-

Table 5. Production Rates Based on Total of 215,970 Fbm.

Item	Time	Fbm for each man-hour	Fbm for 8-hour man-day	Man-hour for each M fbm
	Hours			
Felling, bucking	677.0	319	2,552	3.13
Skidding	756.5	285	2,280	3.50
To landing	1,433.5	151	1,208	6.63
Loading	281.0	769	6,152	1.30
Loaded on truck[1]	1,819.0	118	944	8.42

[1] Includes landing construction and miscellaneous which amounted to 104.5 hours.

pended on extraction are listed in Table 4. Felling and bucking required 677 hours, or 37 percent of the total extraction time. Skidding required 756.5 hours, or about 42 percent of the total time. Landing preparation--constructing rollways or setting up and moving the A-frame--required 70 man-hours, or about 4 percent of the extraction cost.

Equipment costs were low. Cost of the power saw averaged 85 cents for each thousand board feet felled and bucked (Appendix, Table 9). Cost of the horse averaged 90 cents for each thousand board feet removed in yarding (Appendix, Table 10). Costs of equipment, power saw, and horse for landing preparation were 9 cents for each thousand board feet.

Loading required 281 man-hours, or about 15 percent of the total extraction time. The horse was used for loading, and the cost was 34 cents for each thousand board feet loaded. Small logs to construct rollways were procured on the area at no cost to the operator. Material for an adequate A-frame on the North Santiam was estimated at $391.30. Depreciation over a 10-year period would cost $39.13 a year and for the 9 months of logging would cost $29.34, or 14 cents for each thousand board feet.

To load a truck required about 3 man-hours, on the average. The total volume loaded, 215,970 board feet, took 92 loads. The average load was 56 logs with a net volume of 2,347 board feet.

Hauling cost $6.00 a thousand board feet.

To cover the costs of bookkeeping, phone calls, and other administrative details, a rate of $1.00 for each thousand board feet was established. These costs amounted to $215.97. In addition, the State Forester required third-party property-damage insurance, including automobile insurance coverage in an amount not less than $50,000 and a performance bond written by a surety company in the amount of $500. Costs were $48.05 and $15.00, respectively. Severance tax at 7 cents for each thousand board feet amounted to $15.12. Total administrative costs were $294.14, or $1.36 for each thousand board feet.

DISCUSSION

For removing small material and thinning young dense stands, such as that on the North Santiam Forest Management Area, equipment and procedures are required that are different from normal logging operation.

Density of the stand influences the efficiency of the felling operation, through the number of hangups, and the efficiency of skidding, through maneuverability. Steep topography and irregularities of the ground can seriously lower production. Small material requires more felling time and more skidding to remove each thousand board feet from the woods; the production rate is lowered and the cost of logging increased.

It is necessary, then, to keep operating costs at a minimum and to keep the logging simple; expensive equipment and complicated methods cannot be employed. Success depends on the skill of the operator more than on mass production. Independent operators (gyppos) working for themselves and using horses for skidding and, perhaps, loading are ideally suited to this work.

The importance of the operator's attitude cannot be overemphasized. An operator who not only understands the logging procedures but also appreciates the theory of thinning is much more careful and efficient than one who does not.

Costs of extraction

Any light power saw can be used for felling and bucking. A direct-drive saw is more efficient in the hands of an experienced faller than a gear-driven saw. Felling experience is particularly valuable in the first two or three thinnings when the stand is dense, although, even with experience, it is not unusual to fell a tree so it catches against other trees; often it can be rolled down with a peavy but sometimes the skidding equipment is required.

Skidding can be done by lightweight crawler tractors, rubber-tired farm tractors, horses, or special equipment designed for thinning. The horse is particularly adapted for skidding small material in dense young stands on favorable terrain. Although whole trees can be skidded and then bucked on the landing, the difficulty of moving long pieces through dense timber can result in lower production and more damage to the residual stand; in such instances, logs must be bucked in the woods.

A horse can move several small logs or one large log easily; a single horse is more maneuverable than a team. Horses are quick to

learn and become adept at skidding logs in difficult places. They are inexpensive. A horse and equipment can be purchased for about $200 and can be used for at least 8 years; thus the cost of owning and maintaining a horse will not exceed $1.50 a day.

If the operator is using mobile loading equipment, no landings need be constructed; the logs are decked in the roadway. If, however, the operator plans to use an A-frame or a rollway, a landing is necessary. Landings should be planned as permanent structures and built at the same time the roads are constructed. Because a large pile of logs complicates loading procedure, landings should be small, holding not more than two loads (Figure 8). In a thinning operation, the logs should move from woods to landing to mill as quickly as possible.

The loading equipment can be expensive for the small operator, who must keep cost down. The larger operator can afford more efficient mobile loading equipment, such as a truck-mounted loader or a fork lift loader, but with such equipment idle time costs money. Cheap-

Figure 8. Small logs on a rollway landing.

er loading devices--but more time consuming--are the A-frame and the rollway. Of the two, the rollway is the most efficient and least expensive. Material for a rollway good for several seasons can be cut in the woods. For the A-frame, depending upon the kind constructed and whether the equipment is new or used, costs will vary from $150 to nearly $1,000 for the blocks, lines, and end hooks. For small logs, a light, inexpensive A-frame is suitable.

The hauling equipment must suit the product removed: poles and piling, sawlogs, or pulpwood bolts. For sawlogs, most operators use short-log trucks that hold logs up to 24 feet long. If tree-length logs are taken to the mill, as is sometimes done, a long-log truck is required. Small operators must contract the hauling; operators with larger production might own one or several trucks.

Costs of administration

Costs of administration include bookkeeping, and the taxes, bonds, and insurance necessary to the operation. Normally, these costs are low and will decrease for each thousand board feet as the volume removed increases.

Costs of management

Costs to the landowner are in direct management, road building and maintenance, and fixed management. Returns are in stumpage, profit, and risk.

Direct management includes marking, selling, and supervision. Selection of trees for removal can be rapid. Particularly for the first thinning when many deformed trees are removed, the trees seem to "mark themselves." Speed of marking will be increased by selecting only the trees that obviously should come out and leaving doubtful trees for the next thinning. This is an advantage of light, frequent thinnings.

Selling may be as simple as contacting a logger, or it may involve advertising for bids. A contract must be drawn up specifying the details of the operation. The amount of supervision needed will depend upon the operator's experience.

Although no costs for these items were obtained on the North Santiam project, experience has indicated that they will not exceed $2.50 for a thousand board feet. Worthington and Fedkiw (Reference 9) have calculated marking costs at $1.05 and selling and supervision at $1.20 for each thousand board feet. Estimated costs on Forest Research Laboratory projects are also in this range.

Roads are an investment in the management program. They will be used in future thinnings, will make salvage operations possible, and will provide access for protection and administration (Figure 9).

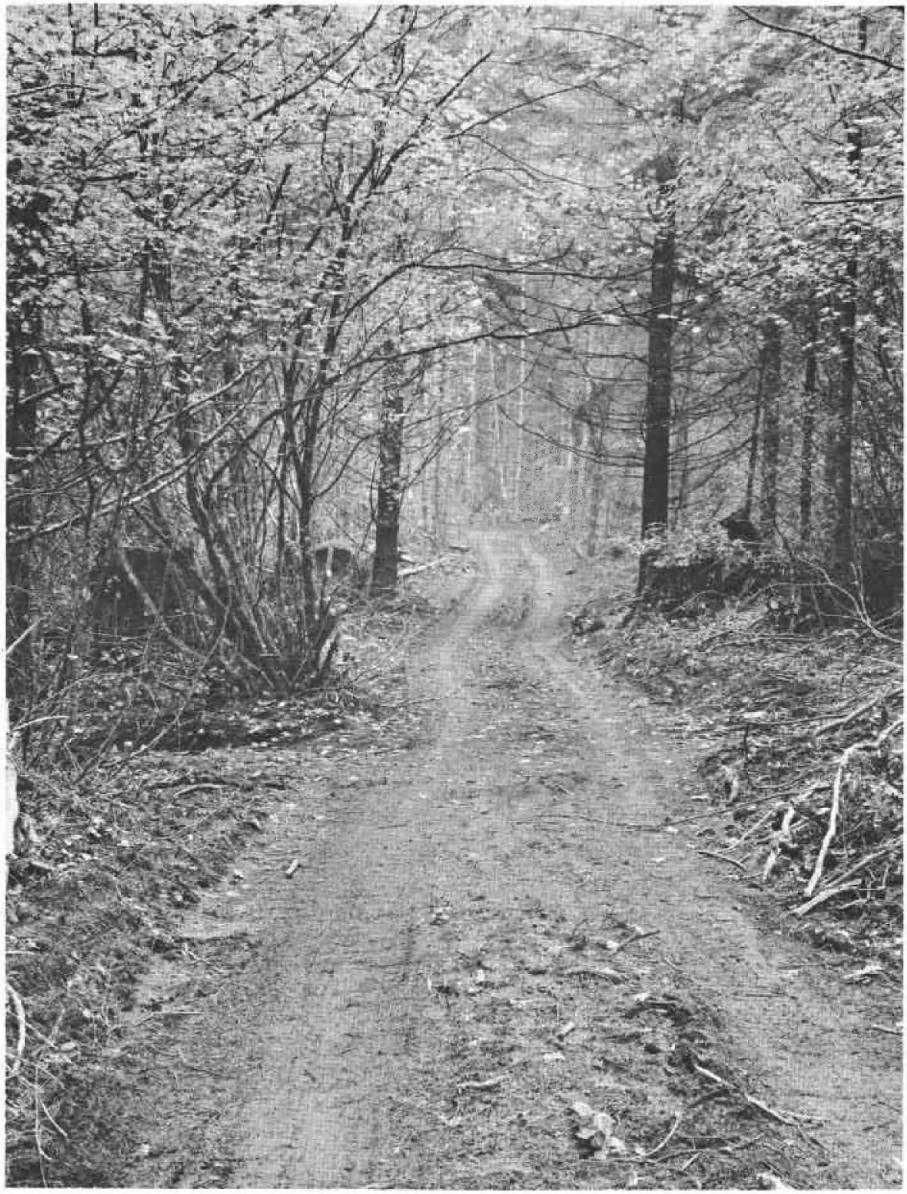

Figure 9. A secondary road constructed for the North Santiam thinning.

Table 6. Costs for Commercial Thinning on the North Santiam Forest Management Research Area, 1960-1961.

Item	Costs for operation					Costs per M fbm			
	Extraction only				All items	Extraction only			All items
	Time		Money				Money		
	Basis	Portion	Labor[1]	Equipment, supplies		Time	Labor	Equipment, supplies	
	Hours	Percent				Hours			
Direct costs of extraction									
Felling and bucking	677.0	37.2	$2,031.00	$183.67	$2,214.67	3.14	$9.40	$0.85	$10.25
Skidding	756.5	41.6	2,269.50	195.25	2,464.75	3.50	10.51	0.90	11.41
Making landing[2]	70.0	3.8	210.00	18.53	228.53	0.32	0.97	0.08	1.05
Loading	281.0	15.5	843.00	101.87	944.87	1.30	3.90	0.48	4.38
Misc. equipment	---	---	---	12.90	12.90	---	---	0.06	0.06
Misc. labor	34.5	1.9	103.50	---	103.50	0.16	0.48	---	0.48
All extraction	1,819.0	100.0	$5,457.00	$512.22	5,969.22	8.42	$25.26	$2.37	27.63
Hauling					1,295.82				6.00
Administration									
Bookkeeping[3]					215.97				1.00
Severance tax					15.12				0.07
Bond					15.00				0.07
Insurance					48.05				0.22
All administrative costs					294.14				1.36
All logging					7,559.18				34.99

Direct management expenses[4]		
Marking	226.77	1.05
Selling and supervision	259.16	1.20
All management costs	485.93	2.25
Total operation cost	8,045.11	37.24
Road investment[5]	1,175.17	5.44
Stumpage returns[6]	1,038.29	4.82
Sales price of logs at mill	$10,258.57	$47.50

[1] Labor at $3.00 an hour.

[2] Equipment and supplies at actual cost for North Santiam operation.

[3] Estimated at $1.00 for each M fbm.

[4] Management expenses were estimated from experience.

[5] This thinning should not bear the entire cost of road building, because it is an investment.

[6] Returns may be assigned as stumpage to fixed management costs or to profit and risk.

Two dispositions of road costs are possible, depending upon the financial condition of the landowner. Some landowners must pay road costs from the logging operation because they lack capital. Other landowners may prorate the costs over several thinnings and the final harvest.

In the North Santiam project, the returns from thinning were adequate to fund the road investment. Because of the gentle and stable terrain and the simplicity of the road, the total cost of $1,175.17 on that project is probably the lowest figure that could be anticipated for secondary roads. For thinning, secondary roads should not be high speed roads. Dirt roads constructed with a bulldozer and provided with culverts and drainage are satisfactory. The roads as built were adequate for the operation described and will do for operations to follow, provided extraction methods do not change. If the terrain were steeper, however, or the soil less stable, the road costs would be higher. Gravel for an all-weather road would also increase costs materially.

For the purposes of this paper, fixed management costs, stumpage, and profit are considered as one item. Such fixed management costs as taxes, protection, and administration are annual, but stumpage and profit attach to a particular operation. Each owner or owner-operator will probably distribute these costs and returns differently. The small operator might use all surplus for fixed management costs and delay stumpage and profit returns to later operations. The large owner might prorate a portion of these costs to each item. In the final analysis, including all costs, the returns to the landowner from the North Santiam operation were $4.82 for each thousand board feet logged, for a total of $1,038.32 (Table 6). In addition, the landowner received an investment in roads of $1,175.17. This then represents a total return of $2,213.49.

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APPENDIX

Table 7. Data on Size of Sawlogs Removed in the Thinning Operation, North Santiam, 1960-61

Number of logs	
Total removed	5,138
Diameter of logs	
Range, inches	6-22
Average log, inches	9
Volume of logs	
Gross volume, fbm	217,970
Net volume, fbm	215,970
Average log, fbm	42
Defect, fbm	2,000
Defect, percent	less than 1

Table 8. Costs of Road Building.

Item	Cost
	Dollars
North Side Monument Peak Road	
Culverts 2 each 12 in. by 24 ft at $1.35/foot	$64.80
Tractor 30 hours at $9.30/hour	279.00
Powder 2 boxes	24.70
Caps 24 each	5.52
Labor 138 hours at $4.00/hour	552.00
Total for 6,120 feet of road	926.02
Cost for 100 feet of road	15.13
South Side Monument Peak Road	
Horse 16 hours at $0.2581/hour	4.13
Power saw 18 1/2 hours at $0.2713/hour	5.02
Tractor 6 hours at $17.00/hour (labor included)	102.00
Labor 34 1/2 hours at $4.00/hour	138.00
Total for 1,565 feet of road	249.15
Cost for 100 feet of road	15.92

Table 9. Costs of Power Saw with a Working Life of 2 Years.[1]

Item	Cost
	Dollars
Depreciation	
Total cost new, $178.50	
Salvage value, $50.00[1]	
Cost for a year, $64.25	
Cost for thinning operation (9 months)	$48.19
Operation*	
Gasoline	20.78
Oil	8.60
New chains	44.35
Saw repair	49.61
Saw equipment	5.60
Saw files	4.05
Repair labor (3 hours by operator)	12.00
Cost for operation	144.99
Total cost for 9 months	193.18
Cost/M fbm	
Felling and bucking (677 hours)	0.85
Landing construction (35 hours)	0.05
Total (712 hours)	0.90
Cost for a working hour[2]	0.2713

[1] Information from saw dealer.

[2] $193.18 divided by 712 hours.

Table 10. Costs for Horse with Working Life of 8 Years.

Item		Cost
		Dollars
Depreciation		
Total cost of horse and harness, $200.00		
Cost for a year, $25.00		
Cost of thinning operation (9 months)		$18.75
Maintenance		
Oats		65.15
Hay		85.65
Barn and care		77.00
Farrier		25.00
Flyspray and absorbine		5.07
Harness repair		0.25
All maintenance		258.12
Total cost for 9 months		276.87
Daily cost for 268 days		1.02
Cost/M fbm		
Yarding	(756.5 hours)	0.90
Loading	(281.0 hours)	0.35
Landing construction	(35.0 hours)	0.04
Total	(1,072.5 hours)	1.28
Cost for a working hour[1]		0.2581

[1] $276.87/ 1,072.5 hours.